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ANNUAL REPORT

LAKE STATES FOREST EXPERIMENT STATION
FOREST SERVICE

U. S. DEPARTMENT OF AGRICULTURE

E. L. DEMMON, DIRECTOR

1948



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EXPERIMENT STATION

Lake States Forest Experiment Station

ANNUAL REPORT FOR 1948

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TWENTY-FIVE YEARS OF FOREST RESEARCH IN THE LAKE STATES

Twenty-five years is not long in the life of a forest, but it covers almost the entire period of organized federal forest research in the United States. It was in 1921 that the U. S. Forest Service began to develop regional forest experiment stations with the objective of having an adequately manned and equipped station in each of the 10 or 11 important forest regions of the United States. Three of these stations were already established when the Lake States Forest Experiment Station was set up on July 1, 1923, with headquarters at University Farm, St. Paul, Minnesota, in cooperation with the University of Minnesota.

Then - 1923

By 1923 sawlog operations were on the wane in the Lake States; pulpwood forestry was just getting under way. The big problem had to do with the future of the tremendous area of forest land, for the most part heavily cut-over and severely damaged by fire. Improved fire protection, better management of the remaining old growth and of merchantable second-growth stands, care in handling unmerchantable young second growth and restoration of denuded areas - these were major problems demanding attention. The small staff, of five technical men and one clerk plunged boldly into studies of these problems in cooperation with the forest schools, state forest services, national forests, and forest industries.

In 1923 there were only 3 national forests in the Lake States comprising 1-1/4 million acres; organized state forests covered less than 1 million acres; and county, school and municipal forests were virtually nonexistent. The great bulk of forest land was in private ownership although vast acreages already were in tax default.

Some 45 technical foresters were employed in the region about as follows: 10 on the national forests, 24 by the states, 5 by the Station, and 6 by industry. State forest fire protection organizations were operating in Minnesota, Wisconsin and Michigan but none was manned or equipped to an extent commensurate with the job. Timber cutting on national and state forests was conservative and represented only the most extensive type of silviculture. About 45,000 acres had been planted, 40,000 acres of this by state and federal agencies. The new foresters in industry functioned chiefly as timber and land buyers. Only three extension foresters were assisting in farm forestry problems.

1/ Raphael Zon, Director; Joseph Kittredge, Tr. and J. A. Mitchell, Silviculturists; H. J. A. Grossman, Assistant Silviculturist; A. E. Wackerman, Forest Assistant; and Mary A. Norton, Senior Clerk

Now - 1948

In the last 25 years, marked progress has been made in forestry in the Lake States region. In 1948 there were 7 national forests covering some 6 million acres, other federal forest holdings totaled about 1-1/2 million acres, state-owned forest land comprised about 9 million acres -- half of it in 61 state forests, some 8 million acres were in county and municipal ownership, nearly 16 million acres were in farm woodland, and an equal area was in other private ownership. Good cutting practices were in force on the national forests and on more than one-half of other public forest lands, but they were followed on only a small portion of private forest lands. Destructive cutting was still prevalent on 15 percent of private holdings. Forest fire protection had improved greatly both in coverage and effectiveness. State and federal organizations were now using radio, aerial patrol, tractors, bulldozers, tanker trucks, and other modern equipment in fighting fires.

The number of technical foresters employed in the Lake States numbered more than 300 in 1948. Several foresters handled silvicultural regeneration, and management practices on private operations. About two dozen publicly employed foresters were available to advise farmers and other small timberland owners in handling woodlands. Agricultural Conservation Program (AAA) payments were available to farmers for carrying out approved forestry practices. About 1-1/2 million acres had been planted, approximately one-sixth of it by private owners.

Today only one of the original Station members (J. A. Mitchell) remains on the staff. Raphael Zon, director emeritus, guided the organization during its first 21 years. However, other foresters have taken over and are carrying the program forward.

The Station's Contribution

Of course, not all the progress in Lake States' forestry during the last quarter century has resulted from the work of the Lake States Forest Experiment Station. Yet the Station has made many contributions to progress. Among other things, the Station has:

1. Developed sound methods for growing, cutting, and regenerating such important timber types as jack pine, red pine, black spruce, and aspen.
2. Determined the best silvicultural and economic stocking at which to grow northern hardwoods (9-1/2 million acres), the most abundant remaining source of saw timber.
3. Developed seed handling, forest nursery practices, and planting techniques which proved of value to large-scale reforestation programs.

4. Devised improved methods of scaling timber which resulted in satisfactory accuracy in a fraction of the usual time.
5. Constructed volume, growth, and yield tables for the principal tree species of the Lake States.
6. Prepared fire danger meters and dispatching guides by which foresters could translate weather factors into relative degrees of fire danger, and organize their forces accordingly.
7. Made the first field survey of the forest resources of the Lake States in 1935-1937, brought it up to date in 1944, and started a resurvey using aerial photographs and other modern techniques.
8. Conducted studies on tax delinquency in the cut over area and made suggestions for handling this new public domain
9. Carried on soil erosion research in the nonglaciated region of Minnesota and Wisconsin.
10. Guided the Prairie States Forestry (Shelterbelt) Project in its program of tree planting from North Dakota to Texas, which program was suggested in 1933 by Raphael Zor, then Director of the Station.
11. Studied the relationship between the forest and such animals as the snowshoe hare, white-tailed deer, and the beaver
12. Assisted during the war in furthering timber production (TPWP and RPS) by advising operators and helping obtain critical equipment and supplies and by maintaining records of production
13. Aided the war effort by demonstrating that the rubber bearing Russian dandelion, Koksaghyz, could be grown successfully in the Lake States, and helped guide the Forest Service project in this field.

Research is useful only if the information resulting from it is put into the hands of those who can use it. To that end the Station issued over 1,000 publications during its 25 years of existence. Over 300 of these have been Technical Notes, brief reports released as results become available. A complete list of these publications is contained in Station Paper No. 15, to be issued early in 1949.

Looking Ahead

Gratifying as the past 25 years' progress in forestry has been, much greater advances will be needed during the next quarter century if Lake States' forests are to contribute fully to the welfare of the region in the way of products and employment. Forest research, too, must be

accelerated to guide the expanded conservation program required. The first steps have already been taken by localizing studies through the establishment of forest research centers in every part of the region except southern Minnesota and southern Wisconsin. Support for a full forest research program will come with an awareness of the urgency of forest conservation. Only then can the Station carry out its obligations to seek and develop the best methods of practicing forestry.

The Station's Current Activities

The Lake States Station, within the limits of its resources, carries the federal government's share of forestry investigations in this region. Its program of research has been concentrated mainly in the northern part of the Lake States area, and operated, for the most part, from its three field centers: The Headwaters Center at Grand Rapids, Minnesota; the Northern Lakes Center at Rhinelander, Wisconsin; and the Upper Peninsula Center at Dukes (near Marquette), Michigan. On July 1, 1948, funds were made available to set up an additional forest research center in southern Michigan. A preliminary analysis of forestry problems in that area has been made in cooperation with federal, state, forest school, and private foresters; selection of headquarters, experimental forest areas, and technical personnel is in progress.

Much of the Station's research program is localized by major forest types. Detailed field research is concentrated on experimental forests, mostly set aside on national forest lands. During 1948, an experimental forest in the spruce type was selected on state land near Big Falls, Minnesota, and placed under cooperative agreement with the State Division of Forestry.

The Station plans its field program and reviews its findings currently with advisory councils for each field center. These councils are made up of local representatives of federal and state forestry agencies, forest schools, and private forest industries. The councils help plan the general research program and specific projects from year to year, insuring a broad, correlated attack, and preventing unnecessary duplication or wasted effort. During 1948, two advisory council meetings were held at each of the Upper Peninsula and Headwaters Centers, and one at the Northern Lakes Center. A regional investigative program conference with members of the Regional Forester's organization was held at St. Paul headquarters.

The following annual report summarizes in brief the highlights of Station findings for 1948, many of which have resulted from several years of continuous research. A complete list of Station publications for 1948 is included at the end of this report.

Plans for 1949 contemplate a continuation of current investigations, with progress and final reports to be issued as rapidly as results justify. The Station issues technical notes and Station papers at quarterly intervals, and contributes currently to many professional forestry and other journals. A list of Station personnel is also included at the end of this report.

FOREST ECONOMICS

The Station's current program includes three major forest economics research projects, in addition to studies of the financial aspects of forest management at each research center. These projects are (1) the forest survey, (2) a resource analysis of the Park Falls, Wisconsin, area, and (3) analysis of the pulpwood situation in the Lake States.

Forest Survey

The Station, in cooperation with the states and other forest landowners, is undertaking a complete inventory of forest land and timber resources, to be completed by 1956 and to be kept current thereafter.

Unlike the previous survey (1933-36) which provided statistics only for relatively large units of area (4 to 6 per state), the present project will provide forest information by individual counties. For national forests and many state, county, and other forests where intensive management is contemplated, it will provide detailed maps and refined estimates of forest areas by types and timber volumes. The survey varies in intensity from place to place, but employs a uniform system of classification and uniform units of measurement, so that all parts can be combined readily into county, state, and regional summaries.

As of December 31, 1948, about one-eighth of the current Lake States' survey has been completed. It was farthest advanced in northern Minnesota and southern Michigan. New air photos have been obtained for 20 percent of the area and field inventories have been completed for 21 percent. Progress on these two phases of the survey are shown in the accompanying map. Office computing and report writing are somewhat behind, as shown in the following table:

Status of Forest Survey in Lake States

December 31, 1948

State	: Area : to be : surveyed	: New : air photos : obtained ^{1/}	: Field : inventory : completed	: Office : computing : done	: Reports : completed
<u>Thousand acres -- forest land</u>					
Minnesota	19,700	8,000	6,780	3,210	<u>2/</u> 1,027
Wisconsin	17,000	1,100	200	100	0
Michigan	19,000	2,200	4,580	2,290	<u>3/</u> 1,125
Lake States	55,700	11,300	11,560	5,600	2,152
Percent	100	20	21	10	4

^{1/} Ten-year-old AAA photos being used for portions of the region.

^{2/} Crow Wing and Aitkin counties, Minnesota.

^{3/} Marquette county, Michigan

Preparing estimates of annual drain on Lake States forests caused by lumbering and pulpwood operations and for other products is a separate phase of the forest survey. For the years 1946 and 1947, the U. S. Bureau of the Census provided statistics for lumber production, but it does not plan to do so for 1948 and 1949. The Station is obtaining information on drain from products other than lumber, by direct contact with producers or users. In 1948, it received valuable help from the Michigan College of Mining and Technology in a canvass of timber use in iron and copper mines.

Estimating current growth and the "allowable cut," (optimum amount of timber to cut each year while building toward a desirable sustained-yield status) is another phase of the survey under way.

Resource Analysis of Park Falls (Wisconsin) Area

The final stages of virgin timber liquidation in northern Wisconsin have caused many forest industries to close, and have had an unsettling effect upon local economy. A typical case is the area surrounding Park Falls in the northwestern part of the state. This area of 1-1/2 million acres embraces part of the Chequamegon National

PROGRESS OF FOREST SURVEY JAN 1949

-  INVENTORY PHASE COMPLETED
-  INVENTORY PHASE UNDERWAY
-  NEW AERIAL PHOTOGRAPHS

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MILES

Forest, several state and county forests, and private lands in various categories. In 1948 it supported a pulp mill, two veneer mills, several sawmills of various sizes, and a few specialized forest industries.

At the suggestion of the national forest supervisor, the Station made an economic study of this area between July 1947 and December 1948. Results will be reported in a Station paper to be released in 1949. The report covers specifically the opportunities available to various classes of landowners, and suggests types of forest industries best suited to the current period of merchantable timber shortage.

As might be expected, no quick and simple solution is available where excessively rapid and almost complete timber liquidation has taken place. However, the Park Falls situation indicates hopeful possibilities, especially for the period 15 to 20 years hence, provided landowners and forestry agencies cooperate in developing constructive plans for handling the available resources. The general findings are applicable to other forest communities in the northern Lake States.

Analysis of Pulpwood Situation in the Lake States

The Lake States pulp and paper industry which produces about 14 percent of the nation's wood pulp and 17 percent of its paper products, faces serious problems of raw wood supplies. Rising stumpage prices, local shortages of spruce and pine, increased transportation costs, prospective curtailment of Canadian supplies and related problems, are causing concern to the industry.

The Station expects to contribute to the solution of some of these problems by bringing together available information on the regional wood situation, and by investigations in cooperation with the industry and the Forest Products Laboratory, of the physical and economic possibilities of shifting wood consumption from tree species in short supply to those in relative abundance. Work to date has consisted of assembling available data on regional pulpwood requirements and pulpwood supplies.

A Method of Evaluating Land for Pulpwood Production

The Station cooperated with the Nekoosa Edwards Paper Company of Wisconsin in developing a workable method of evaluating pulpwood land for acquisition by industry.

The base value used in the method was the company's "standard" defined as the stumpage value of standing merchantable pulpwood 10 miles from the mill, one-half mile back from a good truck road and under good fire protection. The value of woodlands situated more than 10 miles from the mill can be appraised by discounting the "standard" for extra hauling cost, extra logging cost, or extra protection according to circumstances. In the case of immature timber, it is discounted also for age, degree of stocking, and site conditions, and the situation regarding taxes and other carrying costs is also taken into account.

The method also stresses the "supply" value of wood and permits a company to compare advantages of growing its own pulpwood at various points in the Lake States with importing it from Canada or elsewhere.

Aspen Log and Lumber Grades

Lumber grades for aspen are included in three separate sets of grading rules for the Lake States, yet aspen lumber is usually not graded. Because many new uses have been found for it in recent years, and because each type of use has specific requirements or limitations in the grade of lumber that is suitable, there is a definite need for aspen lumber grades. Lack of grading has deprived aspen of some markets and considerable misunderstanding has occurred between buyers and sellers on the basis of grade rules now available.

From information obtained in a study in northern Minnesota, it is estimated that a million board feet of aspen lumber sawn from aspen stands in that area, with utilization to a 6-inch top, will contain the following amounts of lumber, by grades:

Grade of lumber ^{1/}	Volume in M board feet	Percent
F & S	12	1.2
Selects	8	0.8
No. 1 Common	120	12.0
No. 2 Common	520	52.0
No. 3A Common	200	20.0
No. 3B Common	140	14.0
Total	1,000	100.0

^{1/} National Hardwood Lumber Association grades.

For the purpose of appraising grade yield of aspen logs under current methods of utilization and production, information was collected on a sample of 1,087 logs at three mills in northern Minnesota. Preliminary log grades were defined and the logs were graded and sawed. Logs over 9 inches in diameter showed a substantial difference in lumber grade yields for different log grades. For example, 10-inch grade No. 1 logs average 35 percent yield of Number 1 Common or Better lumber as compared to 21 percent for grade No. 2 logs and 2 percent for grade No. 3 logs.

This study disclosed that adoption of a standard system of lumber grading and establishment of log-grade specifications for aspen in the Lake States would be helpful to both buyers and producers. Log and lumber grading can help direct the material into specific uses for which it is best adapted and can aid the forest manager in better evaluating aspen timber.

FOREST MANAGEMENT

Optimum Economic Stocking for Northern Hardwoods

Cuttings in old-growth northern hardwoods on the Upper Peninsula Experimental Forest near Dukes, Michigan, have in the past been analyzed from two points of view. Recommendations for cutting in order to obtain optimum growth have been expressed (1) in terms of the proportion of stand to cut or leave, and (2) the volume to leave after cutting.

During 1948, a third approach was developed. To many forest owners the interest earned on the forest investment, as represented by land value, residual growing stock, and taxes, is of greater importance than tree growth. Accordingly, eight different degrees of cutting ranging from clear cutting to an uncut tract were studied to determine the volume of growing stock that paid off best financially.

For each degree of cutting under sustained-yield, interest earned was calculated. Actual land value, taxes on similar stands in the same locality, and logging costs based on local experience were used. Average growth for the past 15 years was available for each cutting method. Defect and log grades were also taken into account. Prices in effect in 1945 were used for all phases of the appraisal to eliminate any speculative value increase. This procedure tended to keep interest rates on the conservative side. Cutting cycles of 5, 10, 15, and 20 years were considered in the analysis.

The results were curved to show interest earned for a series of residual volumes ranging from 0 to 9,500 board feet net per acre. A residual volume of 3,500 board feet per acre with a 15-year cutting cycle showed the best investment in terms of interest earned with a rate of 3.6 percent compounded. With this same cutting cycle residual volumes of from 2,500 to 5,500 board feet earned 3.0 percent compound interest or better.

Comparing this optimum economic stocking of 3,500 board feet per acre with optimum stocking for growth of 6,000 board feet round in a previous study, it is evident that financial considerations operate to reduce the volume that should be retained as growing stock. However, stockings of from 4,500 board feet to 5,500 board feet per acre showed good growth in the preceding analysis and also earned good interest. Therefore, maintaining about 5,500 board feet per acre following cutting (close to the growth optimum on 6,000 board feet) in upland hardwoods of good productivity should be satisfactory on both counts. For companies or managers of public forests whose main objective is to grow the greatest possible volume per acre, there is no point in reducing the growing stock below 6,000 board feet (Scribner) per acre.

Continuous production of saw timber by the selection system will depend upon an even distribution of different size classes, and the

retention of enough merchantable trees at all times to provide for future economic cutting operations. Adequate tree size distribution would be easier to maintain where stocking does not fall much below 6,000 board feet per acre (the growth optimum) than where it is as low as 3,500 board feet (the optimum for interest earned). It should be pointed out that these experiments were conducted in stands predominantly of sugar maple, with about 20% cull following cutting, averaging 2-1/2 logs in height, and with no hemlock present.

Practicability of Thinning Black Spruce for Pulpwood

Previous studies demonstrated the possibilities of utilizing black spruce pulpwood to a 2-1/2 or 3-inch minimum top diameter. In order to determine whether it is practicable to make light thinnings in black spruce stands and whether the pulpwood produced can be used successfully in the manufacture of groundwood pulp, a project was conducted in cooperation with the Blandin Paper Company, Maurice Salisbury Company, and the Chippewa National Forest in northern Minnesota.

The cutting was done on 37 acres of black spruce swamp in a 75-year-old stand. Volumes cut varied from 2 cords per acre to 8 cords per acre, with an average of 3.92 cords per acre. A thrifty, well-spaced stand was left for future growth. Utilization was to a 3-inch top diameter.

Analysis of costs and returns from this operation showed that when the market price for black spruce pulpwood was \$20 per cord, the operator had a margin of \$3.48 per cord for stumpage and profit. This compares with \$7.35 per cord determined for a regular operation in a previous study.

It is obvious that a landowner cannot expect as high a stumpage price for material from such thinnings as is paid for mature timber where a large volume per acre is cut. However, if the operator is allowed \$1.25 to \$1.50 per cord for his supervision, as is the practice in some cases, the thinning can still return \$1.98 to \$2.23 per cord to the landowner. This is a substantial return when it is considered that the timber stand has been improved and an increase in future yields can be expected.

Studies on this same wood in the mill showed that pulpwood obtained from such thinnings will not adversely affect the mill output nor the quality of the pulp. Small wood requires more handling, but the extra handling is not sufficient to slow down processing operations. Actually, the wood from this thinning was denser and gave a higher yield of pulp than the ordinary run of wood being used at the mill.

Thinning of young spruce stands made possible by utilization to a small top diameter is practicable both from the standpoint of the woods operation and in the pulp mill.

Cooperative Balsam Fir Yield Study

As a result of declining supplies of spruce and a consequent increase in demand for balsam fir in the Lake States, there is need for growth and yield information on the latter species. Public foresters as well as pulp and paper companies owning forest land want accurate information on future yields of balsam fir under the various conditions where it occurs. Accordingly, a cooperative project was initiated during 1948 to obtain field data and prepare growth tables applicable to balsam fir growing in normal mixture with other species and for varying degrees of stand density. The present study is being limited to the upland type.

Field plots throughout the Lake States were taken by foresters representing the cooperating agencies, including nine pulp and paper companies, six national forests, the Conservation Departments of the three Lake States, Michigan State College, the University of Minnesota, and the Lake States Station. By the end of 1948, 530 plots had been measured.

From a preliminary analysis of the data, it has been found that the basic factors affecting growth and development of balsam fir stands include age, site, proportion of balsam fir, and competition index. The factor of competition index, developed especially for this study, evaluates the amount of pressure exerted on balsam fir development through stand density or crowding and the amount of overhead competition offered by other species through suppression. This index is strongly correlated with stand development. By its use it may be possible to extend the application of site index to stands other than those normally or fully stocked.

The results of this study should be available for use by the fall of 1949.

Winter Injury Survey

In the winter of 1947-48, extensive winter injury resulted in browning of foliage and in some places in considerable mortality on planted and natural conifers in the Lake States. The winter damage became apparent in late February and early March, and was very pronounced in April and May of 1948.

Heavy damage was sustained by commercial nurserymen, in some forest plantations, and in snowtrap plantings. Damage to native species in natural stands was generally less severe.

The comparative damage as rated by browning of foliage in the spring of 1948 and recovery by the fall of 1948 is given in the table below, by species or groups:

<u>Damage as judged in spring 1948</u>	<u>Species</u>	<u>Recovery by fall 1948</u>
Severe	*Scotch pine	Poor
	*Ponderosa pine	Poor
	*Mugho pine	Fair
	*Austrian pine	Poor
	*Norway spruce	Fair
	*Douglas fir	Poor
	*Concolor fir	Poor
	*Non-native junipers	Fair
	Hemlock	Good
Moderate	White pine	Good
	White cedar on uplands	Good
Light	White cedar in swamps	Good
	Balsam fir	Good
	Red pine	Good
None	White spruce	Good
	Black spruce	Good

*Species which are exotics, or not native.

White pine and hemlock made an outstanding recovery. It is very striking that those species which are from European sources or introduced from more distant parts of the United States, where climate is considerably different than in the Lake States, generally showed poor, or at best only fair recovery.

Winter Injury and Seed Source

That there is a relation between seed source and resistance to winter damage was illustrated by experimental plantations in northern Minnesota and northern Wisconsin. Following the severe winter of 1947-48, only 2 percent of the Scotch pines of 20 origins having climates similar to that of the planting site (Chippewa National Forest) were severely injured, whereas over 50 percent of those of 20 origins of milder climates were damaged.

In a 12-year-old plantation on the Nicolet National Forest in Wisconsin, Norway spruces from inland Russia were injured less than those from farther south in White Russia or Serbia; white spruce was less affected than Norway spruce, with the more northerly sources uninjured; red spruce and Serbian spruce were severely injured, while western white spruce from the Black Hills was undamaged. Recovery was best among trees well supplied with moisture and light and relatively free from competition.

Red pine grown from local seed was injured rather lightly in an 18-year-old plantation in northeastern Minnesota, but trees grown from sources in lower Michigan and New England were hard hit. Scotch pines of northern European origin also were lightly injured, whereas those from central European sources were severely damaged. Recovery for both species varied with severity of injury. Trees which had over three-fourths of their foliage damaged usually recovered poorly; those with less showed fair to excellent recovery.

Chemical Brush Control in Forest Management

Dense brush frequently constitutes a serious problem in forest management. It hampers natural regeneration, obstructs ground preparation for planting or seeding, and offers severe competition for young trees. Previous studies indicated that such brush could be successfully eliminated by use of chemicals, but at considerable cost.

Additional studies in northern Minnesota now show that costs can be greatly reduced and that use of chemicals is economically feasible for combating brush in forest management. A good kill of hazel brush can now be had for \$6.00 to \$7.00 per acre by hand spraying. On larger scale operations, using mechanical sprayers, these costs can be even further reduced.

As a result of these findings it has been possible to set up tentative guides to estimate the amount of various chemicals needed to kill stands of hazel brush of different densities. The amounts of chemical herbicides required to kill 1,000 stems of hazel brush are as follows:

<u>Chemical (Trade Name)</u>	<u>Amount of Chemical</u>	<u>Cost</u>	<u>Amount of Water</u>
2-4,D	0.5 ounce	\$.07	2 gallons
2-4,5T	0.1 pint	.10	2 gallons
Esteron 44	0.1 pint	.10	2 gallons
Ammate	1.0 pounds	.13	2 gallons

For a stand of hazel brush averaging 20,000 stems per acre, application per acre would be 20 x 0.5 ounces or 10 ounces 2-4,D mixed with 20 x 2 gallons or 40 gallons of water.

In northern Wisconsin excellent control of alder brush (tag alder) has been obtained by use of Esteron 245 at a dilution of 1 to 200 in water, or 96 gallons per acre. The kill obtained was 93 percent, at a cost of \$12.92 per acre. This technique may have future application in case regeneration or planting is attempted in swamps. Swabbing of ammate on freshly cut stumps, using 2 pounds per gallon of water, gave an 87 percent reduction in stand of alder, but at a cost of \$24.81 per acre.

Use of Mineral Spirits as a Selective Herbicide in Conifer Nurseries

In 1948, some 15 trials were made of mineral spirit sprays to kill weeds in several coniferous forest nurseries in Wisconsin. The material used was Stoddard solvent -- a petroleum product containing about 10 percent of aromatic hydrocarbon. It kills weeds without undue injury to conifers, provided dosages are carefully regulated. The 1948 tests were planned to work out refinements in dosages and to devise precautions for minimizing injury to the trees. An example of the type of weed kill obtained is as follows:

<u>Treatment</u> <u>per acre</u> (Gallons of solvent)	<u>Increase or decrease in weed</u> <u>stand one week after treatment</u> (Percent)
0 (check)	+ 190
40	77
50	- 90
75	95
100	95

Apparently fairly good weed kill can be obtained with dosages as low as 40 to 50 gallons per acre provided spraying is done when weeds are small, preferably under 1 inch in height or spread. When weeds were larger (3 to 6 inches), a kill of only 44 percent was obtained with a treatment of 50 gallons per acre.

It was also discovered that the mineral spirits killed soft-coated weed seeds or those just germinating and which had not yet emerged from the soil. For instance, beds of first-year jack pine, completely weeded by hand and sprayed with Stoddard solvent, showed an 86.2 percent reduction in weed stand from treatment of 50 gallons per acre, and a 98.8 percent reduction in weeds from 150 gallon spraying. The comparative weed stand 32 days after the spraying with a range of treatments is shown below:

<u>Treatment</u> <u>per acre</u> (Gallons of solvent)	<u>Weed stand compared to</u> <u>check plots (after 32 days)</u> (Percent)
0 (check)	100.0
50	13.8
75	10.8
100	7.7
125	3.1
150	1.2

Thus there is a possibility of treating seedbeds before the seed is sown in order to kill the weed seeds without risk of injury to the trees from oil. During the germination stage, some species, notably spruces, are sensitive to the oil. Spraying seedbeds with an overhead water system tends to reduce oil injury if done just before applying the oil. For instance, with a rather heavy dosage of 150 gallons per acre, injury on 1-0 jack pine irrigated just before oil-spray application was 4.2 percent compared with 21.4 percent when irrigated two hours before treatment. Oil injury to trees was also minimized by spraying at night, on cool days, or where beds are shaded.

Savings in weeding costs in conifer seedbeds in Lake States nurseries should average at least 50 to 60 percent, and in some cases will be as much as 80 or 90 percent. Spraying can be done for as little as \$15 to \$20 per acre. Hand weeding costs \$75 to \$100 per acre or more.

Mineral spirits are harmful to most broadleaf or deciduous species.

If generally adopted in the larger Lake States forest nurseries in the North Central Region, the saving in weeding costs by use of oil sprays may amount to as much as \$40,000 per year.

Recent Forest Management Publications

During 1948, two major contributions from the Station's Division of Forest Management were the circulars published on red pine and black spruce management. A limited supply of these publications is available, and copies will be sent on request. Because these publications report on major studies made by the Station over a period of years, summaries taken from them are reprinted here.

Red Pine Management in Minnesota (USDA Circular 778, issued May 1948)

"Red pine, once an important component of the famous virgin pine forests of Minnesota, now present chiefly as second growth has good potentialities for forest management. It makes fairly rapid growth, is comparatively free from insect pests and diseases, and produces high-grade timber. The present rather restricted area of red pine is being expanded through forest planting. Cutting experiments and demonstrations were started in 1926 and large-scale tests of timber management date back over 40 years. The results presented here cover (1) seed-tree cuttings, (2) two-cut shelterwood methods, and (3) more intensive forest practice which provides for frequent light thinnings and intermediate cuttings followed by shelterwood cutting near the end of the rotation

"Experience in managing red pine began with the passage of the Morris Act of 1902, which established the Chippewa (then Minnesota) National Forest and prescribed the leaving of seed trees in the original logging. These seed-tree cuttings as they were applied to red pine had many shortcomings, but were responsible in part for the generally

well-stocked condition of logged-off lands where fire did not destroy advance growth. The application of the seed-tree method was the first large-scale effort to conserve red pine and pave the way for more intensive practices to follow.

"Two-cut shelterwood cuttings have been practiced on a moderate scale with quite satisfactory results. Under such a method there is less danger of brush invading the site and considerably more assurance of getting satisfactory reproduction than under the seed-tree method. Moreover, growth per acre of merchantable wood between the time of the first cut and the removal of the stand is much greater than under the seed-tree method, a point of considerable significance when the interval between cuts is as long as 15 or 20 years. To obtain satisfactory growth the method must be applied before the stand loses its vigor.

"Intensive forest management which calls for frequent thinnings and light improvement cuttings is far superior to a two cut system and is generally feasible in red pine because of good markets and accessibility of the region where it occurs. A variety of forest products, including pulpwood, box bolts, mine timbers, poles, piling, and sawlogs, is usually in demand. Pruning is recommended for production of clear lumber. Early thinning, as shown by tests in overdense sapling stands, will shorten rotations. Thinnings in 40-year-old or younger stands for pulpwood pay their way and improve the forest.

"Light intermediate cuttings in middle-aged stands are shown to be profitable operations. Moreover, when properly carried out, they improve the stand. By making such cuttings at 5- to 10-year intervals, weak trees are salvaged before they die and remaining trees are provided with adequate growing space. Through such practice, more high quality timber is grown and yields are greatly increased, thus providing the owner with far greater returns than under a two-cut system. Yield tables are presented for managed and unmanaged stands. The much greater cumulative yield from managed stands is presented graphically.

"Some advance reproduction may build up in red pine after age 80 as partial harvest cuttings begin, but no special efforts to regenerate the stand need to be made prior to age 120. Shelter wood cuttings are then recommended. If possible these should be made during a good seed year which occurs on the average of one year in four. If brush is heavy, scarification with an Athens disk plow and supplemental planting may be required. By keeping the stand fairly open during the later years of the rotation, the regeneration is allowed to develop. Ample growing space also makes it possible for the overstory to maintain good growth until an age of about 140 years is reached. The final cut should then be made."

Silvicultural Management of Black Spruce in Minnesota (USDA Circular 791, issued October 1948)

"Black spruce, a tree having exceptionally good qualities for pulpwood, forms the principal cover on 1-1/2 million acres of productive swampland in northern Minnesota. It is also the principal species adapted to a large area of deforested swamps. Spruce pulpwood is in much demand, and timber stands are being depleted rapidly. Considerable numbers of black spruce Christmas trees can be obtained from swamps where growth is too poor for the production of pulpwood. Black spruce grows well on upland soils but usually occurs there only in mixture with other species of trees.

"In swamps, black spruce has few competitors and forms stable types that regenerate naturally from seedlings, and to some extent by layering. Many swamp stands are even-aged because of regeneration after forest fires. On uplands black spruce reseeds most successfully following forest fires. In the absence of periodic burns it tends to be replaced by balsam fir, white spruce, and paper birch.

"Its serotinous cones, borne at the tops of the trees, disperse the enclosed seeds slowly over a period of two or three years after ripening. The seeds stored in the cones account for the success of black spruce in reseeding after forest fires. The slow dispersal of the seed also is of value in assuring a supply of freshly scattered seed when stands are cut-over.

"Seedlings as well as older trees can endure much shade but are most successful in sunlight. The seeds germinate best on exposed mineral soil, rotten wood, and peat.

"Black spruce trees grow slowly and in Minnesota rarely attain breast high diameters larger than 17 inches. Growth is well-sustained up to about 100 years on good sites, 140 years on medium site, and 160 years on poor sites. As a result of the exceedingly large numbers of trees in fully stocked stands, pulpwood production is fairly good despite the slow growth of the individual trees. Fully stocked stands on average sites grow at the rate of about one-fourth cord per acre per year. Upland trees become infected with butt rot and succumb to breakage or uprooting at around 80 to 90 years.

"It is recommended that thrifty swamp stands be given a series of periodic light partial cuttings leading to the creation of all-age forests adapted to the selection system. The initial cut should preferably remove not over one-third of the merchantable volume. Such cuts should eventually result in increasing the growth by one-third to one-half. Windthrow has been found to be less of a risk than formerly supposed.

"Badly decadent overmature swamp stands must be clear cut. Although reproduction usually is reasonably adequate, it can be improved by slash-disposal measures such as piling that cause exposure of more of the soil surface. Prevention of logging damage to advance reproduction also helps to maintain satisfactory stocking.

"Nearly pure types on uplands and the fringes of swamp borders should be clear cut when they become mature or show signs of opening up due to wind damage. Reproduction on uplands is likely to include such species as quaking aspen, paper birch, jack pine, and balsam fir, although black spruce will continue as a more or less important element that can be encouraged by release cuttings or in connection with commercial thinnings."

FOREST FIRE RESEARCH

An analysis of Michigan forest-fire records was begun in 1948 in cooperation with the Michigan Department of Conservation. Preliminary analysis shows that the peak of forest fire occurrence in Michigan came between 1930 and 1934. Also, prior to 1930 there was a gradual increase in number of fires per year, but since 1935 there has been a sharp decrease. Most of this decrease came between 1935 and 1940, after which the number of fires per year leveled off. Since 1944 the number of fires has again increased. This latest uptrend is evident even when allowance is made for fluctuations in precipitation. The correlation between total number of fires per year and total annual precipitation is found to be highly significant, which provides a basis for adjusting incomplete fire records of former years.

Fire records for the Lake States as a whole follow much the same pattern as for Michigan. Since 1930 there has been a marked over-all decrease in total number of fires and area burned, together with a corresponding increase in fire-control expenditures. It seems that the point of diminishing returns now has been reached and that, except in Minnesota, further increases in expenditures beyond that necessary to offset increased costs cannot be justified economically. At present, with the exception of Minnesota, protection in the Lake States is reasonably adequate; the average area burned per year is under 0.2 of one percent of the area protected, in spite of severe burning conditions in 1946 and 1948. At present, expenditures for fire prevention and suppression in the Lake States average approximately 4.6 cents per acre per year and the average annual burn 0.17 of one percent.

Correlating forest fire occurrence and behavior with burning index ratings shows that frequency and average size of fire approximately doubled with each higher burning index class. Practically no large fires (100 acres and over) occurred when conditions rated less than moderate, whereas at higher ratings there was a rapid increase in number of fires and size. A study of the underlying factors determining burning conditions indicates that heat needed to make forest fuels inflammable accounts for the close relationship between burning index and fire occurrence and behavior.

SHELTERBELT INFLUENCES

Prior to 1948, the protection benefits of shelterbelts were determined by various physical measurements, such as wind velocity and evaporation, particularly to compare tree belts planted in different directions. To tie these down to a practical basis a study has also been made of the relation of belt direction to farm crop yields. Crop yield analyses have been completed for 200 fields located in Kansas and Nebraska, with a smaller number of samples from the Dakotas yet to be studied.

Preliminary analysis shows that crop yields increase as the protecting shelterbelts become wider or denser, with the greatest effect in fields protected on the south side.

Crop gains to the north of belts in Kansas and Nebraska amounted to about 10 percent for an average corn crop of 25 bushels per acre, but were less for wheat. Even to the north of belts, however, crops gains probably do not compensate for the loss of land occupied by the belt if it exceeds two or three rows in width. Not only did the area benefited increase directly with the height of the trees in the belt (as expected) but the best gains were made on areas protected by the tallest trees.

FARM FORESTRY STUDIES

Improving forestry practices on the farm was the objective of studies made in cooperation with State agencies. These studies were concerned with improvements for small sawmills, desirable stages at which to harvest farm woodland products, wood use in farm buildings, fence post needs, and returns from farm wood-lot cuttings.

Michigan

Studies of small sawmill improvements continued to be the major project of the farm-forestry research program in Michigan.

The study of pneumatic air dogs (used to hold logs on a sawmill carriage) showed that they saved the operator 28-1/2 minutes and increased his net income by \$13.50 per day. Several improvements were made in the design of the air dogs, and arrangements for commercial manufacture are under way.

A lead adjusting device for circular sawmills was developed and tested. This device adjusts the lead by slewing the saw frame rather than by the usual method of slewing the saw mandrel. The saw frame is moved by means of an adjusting screw and is held firmly, permitting operation without stopping the saw. A disk on the adjusting screw can be calibrated to show the amount of change in the lead without actual measuring.

A project was started in 1947 to find a suitable way for a farmer to dry lumber in small quantities and keep it dry. Desiccating chemicals, principally calcium chloride, were used. Results indicated that there is considerable danger of case-hardening by this method, but that if the rate of drying is carefully controlled, lumber can be dried to almost any desired moisture content without damaging it. Further experiments to determine the most effective means to use desiccants, and the relative cost of this method of drying as compared to others, are under way.

Wisconsin

Considerable information on the mixed-oak forest type was published in 1948, including a rather comprehensive Wisconsin Conservation Department bulletin. An interesting point brought out in this bulletin is the direct relationship between site quality, as reflected in the average diameter of the dominant stand, and the estimated recovery of lumber by grades, as follows:

<u>Average Oak Stand Diameter</u>	<u>Ages at Which Average Diameters Are Attained on -</u>	<u>Estimated Yield of No. 1 Common and Better 4/4 boards</u>		
	<u>Poor site</u>	<u>Medium site</u>	<u>Good site</u>	
(Inches)	(Years)	(Years)	(Years)	(Percent of total)
10	75	65	55	13
12	95	80	65	24
14	140	100	80	35
16		140	100	41
18			135	44

This shows why mature timber brings the farmer more money than immature trees. It also indicates that the waiting period between harvests is shorter on the more productive sites. Thus, on poor sites it takes 20 years for the average diameter of dominant trees to increase from 10 to 12 inches, whereas on good sites it takes only 10 years. However, there is an age limit beyond which it is not practical to hold oak stands merely to obtain larger trees.

Another published study, of diameter-growth characteristics of northern red oak (Quercus borealis), led to the following tentative conclusions:

1. This species typically forms even-aged forests which, in southern Wisconsin, appear to be mostly of seedling or seedling-sprout origin, and which developed under conditions of little initial suppression.
2. In some cases, northern red oak occurs group wise in mixture with more tolerant hardwoods such as sugar maple and basswood. Under such conditions, some of the oak recovers well from prolonged crowding and subsequently forges ahead of its competitors.
3. There is doubt that diameter growth of coppice following logging of present-day oak farmwoods will be satisfactory, since the diameter-increment rate in a 55-year-old mixed-oak stand during the last 15 years was only 50 percent of the mean annual figure for the preceding 40 years.

Minnesota

A study of factors affecting the use of farm-woodland products in Minnesota farm buildings made under the direction of the Forest Products Laboratory brought out the following points:

1. Many farmers are interested in modernizing their farm structures, especially in making animal-housing buildings warmer, but this has introduced problems of condensation and resulting decay.

2. Extensive use of native lumber has declined in recent years, but there are possibilities of much greater use on many southern Minnesota farms if insulation and ventilation problems are overcome.
3. There is great need for research and education, not only in insulation and ventilation of animal-housing buildings, but also in the relationship of lumber and nonwood products in such structures.

To produce better fence posts from local timber for Minnesota farms, a joint project was developed with the Minnesota Agricultural Experiment Station in the fall of 1948. Background for the study included the following points:

1. About 10 million posts are needed annually to maintain the fences on Minnesota's 188,952 farms. As the supply of white oak and cedar decreases, farmers are using more of the less durable species, such as pine, aspen, birch, tamarack, and even willow and cottonwood. Most of these posts are used without preservative treatment and last only a few years. As a result, steel posts are used in increasing numbers. They are easy to set and are durable unless subjected to heavy pressure.
2. Farmers have generally used larger wooden posts of the non-durable species to provide somewhat longer life. However, small posts (2-1/2 to 4 inches in diameter) of these same species can be treated to make them more durable. These small posts, if properly pointed, can be driven nearly as easily as steel posts.
3. Minnesota's forests contain large quantities of young jack and red pine in need of thinning, and young tamarack being attacked by the sawfly. Cutting in these stands could supply large quantities of small posts.

Information is needed on the economic harvesting of these small trees and their processing into suitable fence posts; on the strength, depth of setting, and spacing of small posts; and if they are to compete successfully with steel, on the type of point and on the best type of power-driving equipment to use. The project aims to answer these questions.

Farm Forestry Demonstrations

In order to demonstrate what may be done by farmers or other small woodland owners on their own stands, 40-acre tracts have now been set aside on three of the Station's experimental forests. Each year the equivalent of the total annual growth from each area is being cut. The first cut usually is a salvage operation to improve growing conditions. Financial returns during 1948 from the "forty" on the

Pike Bay Experimental Forest in northern Minnesota (mixed hardwoods, aspen, and pine) were as follows:

<u>Products Removed from 40 Acres</u>		<u>Value at Roadside</u>
Veneer logs	2,500 board feet	\$122.15
Sawlogs	3,190 board feet	112.30
Ties	38 pieces	30.40
Box bolts	2.3 cords	23.00
Pulpwood	9.2 cords	69.70
Fuelwood	15.0 cords	90.00
Total value		447.55
Expenses (excluding stumpage)		42.00
Net return to owner-operator		\$405.55
Return per man-hour (256 hours)		\$ 1.58

Similar cuttings on 40-acre tracts of second-growth northern hardwoods on the Upper Peninsula Experimental Forest in northern Michigan and on the Argonne Experimental Forest in northern Wisconsin yielded the operators returns of \$1.35 and \$1.28 per man-hour respectively after payment for stumpage. In the latter case, if the timber had been owned by the operator, with an annual tax of \$12 on the 40-acre tract, his wage per man-hour would have been \$1.77.

The demonstrations on the study areas were handled in cooperation with the Station Extension Services and local County Agents.

FOREST WILDLIFE RESEARCH

(Conducted by Fish and Wildlife Service in cooperation
with the Forest Service)

Ecological Studies of the Wildlife on Isle Royale National Park (Michigan)

From observations on 1,238 sample moose browse plots in May 1948, it is clear that the moose browse supply has deteriorated a great deal since the 1945 investigation. Twelve of the top-ranking foods are: balsam fir, paper birch, mountain ash, aspen, willow, red osier dogwood, ground hemlock, mountain maple, honeysuckle, sugar maple, hazelnut, and fire cherry. Eight of these foods were utilized in excess of their regenerative ability, and six of them made up more than three-fourths of the food eaten. Barking of standing aspen is now quite common and white cedar also has been browsed. Aspen, formerly the number one food, is now in fourth place because so much of the reproduction has been killed. Balsam fir, an important moose food, is now being replaced by white spruce. Paper birch appears to be able to withstand heavy moose browse. There are indications that the Isle Royale herd is approaching another die-off.

The food supply for beaver is also seriously depleted and both moose and beaver are competing for the remaining aspen and birch. The bulk of the present beaver food supply is paper birch, a second-rate food.

Direct Seeding Study

Germination tests of repellent treated jack pine seed showed that asphalt emulsion, casco glue, and Latex and Tisdia reduced germination the least. Field tests showed practically no difference in survival between treated and untreated seeds, since the rodent pressure in the experimental area was not great.

Forest Wildlife Studies Needed

In demand now is reliable information on the deer population which various types of forest can maintain without serious damage to forest growth. An answer to this question will require comprehensive studies beyond the means of the present staff. One phase, however, will be undertaken in 1949, in the form of a survey of winter browse conditions on the Superior National Forest, in cooperation with national forest officers and state specialists. An area surveyed about 10 years ago will be re-examined to determine changes during that period.

Although interest in the deer problem overshadows others, there is need to determine more effective methods of preventing snowshoe hare damage. Useful repellents have been developed, but how to protect new

shoots is still not known. Also needed are feasible methods for controlling porcupine damage. A 3-year study in cooperation with the Forest Service and the Wisconsin Conservation Department is planned to determine population, range habits, and workable control methods for porcupine.

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Joseph H. Stoeckeler, Forester, In Charge
Carl Arbogast, Jr., Silviculturist
Nelson T. Samson, Forester (to 3/13/48)
Miron L. Heinselman, Forester (eff. 10/4/48)
Edward R. Stoltz, Clerk

Upper Peninsula Experimental Forest, Duquesne, Michigan

Walter M. Ziegitt, Silviculturist, In Charge
LaMont G. Engle, Forester
Wilho A. Saarninen, Forestry Aide (Research)

Lower Peninsula Forest Research Center, East Lansing, Michigan (Personnel not yet assigned)

Denbigh, Denbigh, North Dakota (inactive)

Forest Influences - Carlos G. Bates, Silviculturist

Forest Fire Control - J. Alfred Mitchell, Silviculturist John S. Crosby, Forester

Forest Economics - Russell N. Cunningham, Forest Economist, In Charge

Economics of Management and Utilization

Howard W. Mayne, Forest Economist

Forest Survey

Arthur G. Horn, Forest Economist

Clarence D. Chase, Forester

Paul C. Guikley, Forester

Harvey M. Seeley, Forester

Statistics

Suren R. Gevorkiantz, Silviculturist

Cooperative Farm Forestry

Michigan - John W. Creighton, Agent

Minnesota - John R. Neetzel, Forester

Wisconsin - Harold F. Scholz, Silviculturist

Forest Biology (Fish & Wildlife Service, U. S. Department of Interior)

Laurits W. Krefting, Biologist

Evelyn A. McCann, Clerk-Stenographer